

**Notice of Allowability**

Application No.

09/693,589

Examiner

Harry Vartanian

Applicant(s)

YANG ET AL.

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**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--**

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 7/6/2004.
2. ☒ The allowed claim(s) is/are 1-15, 17-24.
3. ☒ The drawings filed on 20 October 2000 are accepted by the Examiner.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
  - a) ☐ All b) ☐ Some\* c) ☐ None of the:
    1. ☐ Certified copies of the priority documents have been received.
    2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
    3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

\* Certified copies not received: \_\_\_\_\_.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

**THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
  6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
    - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      - 1) ☐ hereto or 2) ☐ to Paper No./Mail Date \_\_\_\_\_.
    - (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date \_\_\_\_\_.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

**Attachment(s)**

- |   |  |
|---|--|
| 1. <input type="checkbox"/> Notice of References Cited (PTO-892)  | 5. <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)            |
| 2. <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                | 6. <input type="checkbox"/> Interview Summary (PTO-413),<br>Paper No./Mail Date _____. |
| 3. <input type="checkbox"/> Information Disclosure Statements (PTO-1449 or PTO/SB/08),<br>Paper No./Mail Date _____ | 7. <input checked="" type="checkbox"/> Examiner's Amendment/Comment                    |
| 4. <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit<br>of Biological Material          | 8. <input type="checkbox"/> Examiner's Statement of Reasons for Allowance              |
|   | 9. <input type="checkbox"/> Other _____.   |

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### EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Mark K. Brightwell(Reg. #47,446) on 9/15/2004. Applicant attests that no new matter has been added.

The application has been amended as follows:

Claim 1, Line 24:

correlation matrices and said data **vectors** vector;

Claim 2:

The symbol estimation method in claim 1 wherein said **channel responses** channels are convolutions of physical channels and their corresponding pulse shaping filters ~~of said channels~~.

Claim 3:

The symbol estimation method in claim 1 wherein said **channel responses** channels are convolutions of physical channels and their corresponding spreading codes of said signals in a code-division-multiple-access communication system.

Claim 4:

The symbol estimation method in claim 1 wherein said **channel responses** channels are convolutions of physical channels, their corresponding spreading codes of said signals, and their corresponding pulse shaping filters in a code-division-multiple-access communication system.

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Claim 10, Line 5:

into  $dJ \times 1$  blocks which are indexed from one, wherein  $i$  is an integer.

Claim 11, Line 2:

division steps comprise ~~reduction step further comprises~~ putting said second set of

Claim 14, please replace the claim with the following:

14. (Currently Amended) The symbol estimation method in claim 1 wherein said  $[[d]]$  spatial-time correlation matrices denoted by  $T_k$ ,  $k = 0, \dots, -d$   ~~$T_i$ ,  $i = 0, \dots, -d$~~ , are constructed by

$$\frac{\sum_{m=1}^M \sum_{n=1}^{d+k} (H_{d+1-n}^{(m)})^* H_{(d+1-n+k)}^{(m)} + \delta(k) \nu I}{\sum_{m=1}^M \sum_{n=1}^{d+i} (H_{d+1-n}^{(m)})^* H_{(d+1-n+i)}^{(m)} + \delta(i) \nu I}$$

wherein the a channel response matrix  $[[H_i]]$   $\underline{C}_m$  at receiver  $m$ ,  $m=1, \dots, M$ , consisting of  $(d+1)J$  rows, where  $d+1$  is said maximum channel response length, and  $J$  columns, which are the channel responses from transmitters to the receiver  $m$ , is related to  $H_m^{(n)}$   $H_n^{(m)}$ ,  $n = 1, \dots, d+1$  by

$$C_m = \begin{bmatrix} H_1^{(m)} \\ H_2^{(m)} \\ \vdots \\ H_{d+1}^{(m)} \end{bmatrix}$$

$$H_i = \begin{bmatrix} H_m^{(1)} \\ H_m^{(2)} \\ \vdots \\ H_m^{(d+1)} \end{bmatrix},$$

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where  $\delta(\cdot)$  is the Kronecker function,  $\nu$  is the a variance of noise for minimum-mean-square-error joint detection and 0 for zero-forcing joint detection, wherein  $\mathbf{I}$  is an identity matrix.

Claim 15, please replace the claim with the following:

15. (Currently Amended) The symbol estimation method in claim [[1]] 14 wherein said second set of matrices and vectors consists of channel description matrices  $A_1$ ,  $B_1$ ,  $D_1$  and a vector  $Y_1$

wherein  $A_1$  is composed of  $d \times d$  blocks, wherein the  $(p,j)$  block of  $A_1$  is  $T_{-j+p}$  if  $j \geq p$ , and  $T_{-j+p}^*$  if  $j < p$ , where  $p$  and  $j$  are integers;

wherein  $B_1$  is composed of  $d \times d$  blocks, wherein the  $(p,j)$  block of  $B_1$  is  $T_{-d+j-p}$  if  $p \geq j$ , and  $0_{J \times J}$  if  $p < j$ ;

wherein  $D_1$  is  $A_1^*$ ;

wherein  $Y_1$  is  $\sum_{m=1}^M R_m$ , wherein  $R_m$  is said signal obtained from receiver  $m$ .

where  $A_1$  is composed of  $d \times d$  blocks, and the  $(i,j)$  block is  $T_{-j+i}$  if  $j \geq i$ , and  $T_{-j+i}^*$  if  $j < i$ ;

$B_1$  is composed of  $d \times d$  blocks, and the  $(i,j)$  block is  $T_{-d+j-i}$  if  $i \geq j$ , and  $0_{J \times J}$  if  $i < j$ ;

$D_1$  is  $A_1^*$ ; and  $Y_1$  is  $\sum_{m=1}^M R_i$  where  $R_i$  is said signal obtained from receiver  $i$ .

### CANCEL CLAIM 16.

Claim 17, please replace the claim with the following:

17. (Currently Amended) The symbol estimation method in claim 15 [[1]], wherein  $i$  is an integer greater than or equal to one, wherein an  $i^{\text{th}}$  step of said forward division steps comprises: for forward division step  $i$ ,  $i = 1, \dots, S$ ,

$$A_{i+1} := -B_i^* A_i^{-1} B_i + A_i - B_i A_i^{-1} B_i^*$$

$$B_{i+1} := -B_i A_i^{-1} B_i$$

$$B_{i+1}^* := -B_i^* A_i^{-1} B_i^*$$

$$Y_{i+1,k} := -B_i^* A_i^{-1} Y_{i,2k-1} + Y_{i,2k} - B_i A_i^{-1} Y_{i,2k+1}, \quad k=1, \dots, \left\lfloor \frac{L_i-3}{2} \right\rfloor;$$

**wherein said  $i^{\text{th}}$  forward division step further comprises:**

$$D_{i+1} := A_i - B_i D_i^{-1} B_i^* - B_i^* A_i^{-1} B_i$$

$$L_{i+1} := \frac{1}{2}(L_i - 1)$$

$$Y_{i+1,L_{i+1}} := -B_i^* A_i^{-1} Y_{i,L_i-2} + Y_{i,L_i-1} - B_i^* D_i^{-1} Y_{i,L_i}$$

if  $[[L_i]]$   $L_i$  is odd; **or**

$$D_{i+1} := D_i - B_i^* A_i^{-1} B_i$$

$$L_{i+1} := \frac{1}{2} L_i$$

$$Y_{i+1,L_{i+1}} := -B_i^* A_i^{-1} Y_{i,L_i-1} + Y_{i,L_i}$$

if  $[[L_i]]$   $L_i$  is even.

Claim 18, please replace the claim with the following:

18. (Currently Amended) The symbol estimation method in claim **17**  $[[1]]$  wherein said pre-defined stopping criterion is  $L_{i+1}=1$  or  $B_{i+1}=0$ , **wherein an integer variable**  $s$  is set to  $i+1$  and the forward reduction **division** steps stop **when the pre-defined stopping criterion is satisfied.**

Claim 19, please replace the claim with the following:

19. (Currently Amended) The symbol estimation method in claim **18**  $[[1]]$  wherein **said** intermediate solution  $[[\text{step}]]$  comprises solving **the equation**  $D_s X_s = Y_s$ , **for a vector  $X_s$ .**

Claim 20, please replace the claim with the following:

20. (Currently Amended) The symbol estimation method in claim **19**  $[[1]]$  wherein said backward substitution step  $i$ ,  $i = s, \dots, 1$ , comprises:

$$X_{i,1} = A_i^{-1} Y_{i,1} - A_i^{-1} B_i X_{i+1,1},$$

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$$X_{i,2k+1} = A_i^{-1}Y_{i,2k+1} - A_i^{-1}B_i^*X_{i+1,k} - A_i^{-1}B_iX_{i+1,k+1}, \quad 1 \leq 2k+1 < L_i,$$

$$X_{i,L_i} = D_i^{-1}Y_{i,L_i} - D_i^{-1}B_i^*X_{i+1,L_{i+1}} \quad \text{if } \underline{[[L_i]]} \quad \underline{L_i} \text{ is odd.}$$

Claim 21, Line 11:

correlation matrices and said data **vectors** vector;Please amend the **Specification** as indicated below.

On page 3, lines 31-32, please amend the sentence that begins with "The received signal at each physical receiver . . ." as follows:

**In one embodiment, the** ~~[[The]]~~ received signal at each physical receiver is oversampled at  $M_t$  times the chip rate thereby producing a plurality of received signals each sampled at the chip rate.

On page 4, between lines 6 and 7 (i.e., immediately prior to the paragraph that starts with "FIG. 1 shows one example of an embodiment ..."), please insert the following new paragraph:

**As mentioned above, the received signal at each physical receiver may be oversampled at  $M_t$  times the chip rate. More generally, the received signal at each physical receiver may be sampled with a time interval equal to a  $1/F$  fraction of the symbol time duration (i.e., the fixed time duration of the symbols being used in the system), where  $F$  is an integer no smaller than  $\frac{J}{MM_t}$ , where  $M_t$  is a positive integer.**

On page 4, between lines 39 and 40 please insert the following new paragraph:

**In one embodiment, the channel responses are convolutions of physical channels and their corresponding pulse shaping filters. In another embodiment, the channel responses are convolutions of physical channels and their corresponding spreading codes of the signals in the code-division-multiple-access communication system. In yet another embodiment, the channel responses are convolutions of physical channels, their corresponding spreading codes of the signals, and their corresponding pulse shaping filters in the code-division-multiple-access communication system.**

On page 13, please amend the paragraph that starts on line 11 as follows:

In summary, the solution of the block tridiagonal system of equations as given in (10) is executed with two procedures. In the first procedure, the size of the system of equations is reduced, which is called forward reduction (306), a flow chart of which is shown in FIG. 4. **The**

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**first procedure involves forward division steps which are recursively computed until a predefined stopping criterion is satisfied. The stopping criterion may be the condition that the length of the latest generated right-hand vector is  $d_j$  or that the superdiagonal block matrix in the latest of the series of matrices and vectors becomes a zero matrix.**

In the second procedure, solved unknowns are substituted into larger systems of equations and more unknowns are solved, which is called backward substitution (308), a flow chart of which is shown in FIG. 5.

On page 14, please amend line 7 as follows:

9. Repeat 2 to 8 until  $L_i = 1$  **(or  $B_i = 0$ ).**


Any inquiry concerning this communication or earlier communications from the examiner should be directed to Harry Vartanian whose telephone number is 571.272.3048. The examiner can normally be reached on 10:00-6:30 Mondays to Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stephen Chin can be reached on 571.272.3056. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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